Rare Earths and Other Critical Materials

STATUS UPDATE

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Rare earths are a group of seventeen chemical elements, sixteen of which are found naturally on earth. They have several properties that make them valuable, if not irreplaceable, in the manufacture of certain structural metal alloys, magnets, light-emitting devices, lasers, catalysts, pigments and other high-tech applications.

Rare earth elements are chemically similar and usually found together. Separating them is complex and expensive. They are sometimes associated with elements that are difficult to dispose of, because of toxicity or radioactivity.

After California's Mountain Pass rare earth mine closed in 2002, China became the world's dominant producer, commanding as much as 98% of the market.

In 2010 and 2011 concerns rose about the availability of rare earth elements as China restricted its exports, while demand in the rest of the world grew steadily. Prices spiked in the summer of 2011, with some rare earths reaching 25 times their pre-2010 value. Efforts to identify and ameliorate the risks associated with critical materials emerged world-wide.

China removed its export restrictions in 2015 following a successful action by the U.S., Japan and the EU in the World Trade Organization, but by that time rare earth prices had substantially returned to pre-crisis levels.

The Mountain Pass mine resumed operations, with new ownership and processing facilities, in August 2012, but the parent company, Molycorp, entered Chapter 11 and the mine closed again in 2015. It is reported that the sale of the property to a new owner is imminent, and that the purchaser intends to restart the mine.

Following the 2010-11 price spike, industry around the world reacted by reducing its use of rare earth elements wherever possible. Demand for cerium (used primarily for polishing silicon wafers and glass) declined markedly when users started recycling. Dysprosium use in magnets declined as a result of reduced overspecification and the adoption of a new process that achieves the same results with less of this critical element. Europium prices are now roughly one fourth of their pre-crisis levels as a result of a worldwide switch from fluorescent to LED lighting.

These demand reductions tend to reduce the revenues generated by mines, and therefore threaten the production of other elements that they may produce.

On the supply side of the market, the 2010-11 price surge led many to investigate development of rare earth production outside of China – although bringing new sources of production online takes time, often a decade or more. In early 2017, more than 80 percent of world production still is in China. Of special significance over the longer term, the 2010-11 price surge encouraged a significant amount of mineral exploration, resulting in a more-than seven-fold increase in the quantity of known rare-earth resources outside of China. “Resources” in this context refer to mineral occurrences that are known to exist with a high degree of certainty through drilling or other form of investigative activity and might conceivably be developed into mines in the future. These resources have the potential to help diversify the supply of rare earths. Almost all of these non-Chinese exploration projects are on hold given the low current prices for rare earths. All of these projects require significant technology development to overcome the challenges of extracting and separating rare earths, especially for the resources that are in unconventional mineralogical forms for which commercially viable extraction and separations techniques have yet to be proven.

Recycling of both industrial wastes and end-of-life products, other potential sources of rare earth materials, is very limited at present, but is the subject of significant research and development.

Rare earth supplies currently meet global demand, but demand is projected to rise steadily with increasing electrification of the world’s economy, and shortages may develop within a few years.

Other materials that have essential uses and fragile supply-chains are also considered critical. Lithium’s use in rechargeable batteries places it on this list. Concerns have been expressed about several other elements including cobalt, gallium, indium, helium, graphite and the platinum group metals. According to the U.S. Geological Survey, the U.S. depends on imports for 100% of its supply of 19 materials in addition to the rare earths.

The Critical Materials Institute is a DOE Energy Innovation Hub, funded through the Advanced Manufacturing Office. A partnership of industries, universities and national labs, led by the Ames Laboratory, it seeks ways to diversify the supply of critical materials, invent substitutes and improve the stewardship of existing supplies through improved manufacturing efficiency, reuse and recycling. It has disclosed 61 inventions and submitted 35 patent applications to date. Two patents have been issued and two technology licenses have been issued to industry partners.

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